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REQUIREMENTS FOR 16-MILLIMETER MOTION-PICTURE PROJECTORS

The prospective user of 16-millimeter motion-picture projectors is confronted with the problem of selecting from the various available makes and models, those which satisfy his requirements most economically. If specifications are to be prepared, the problem is that of describing the characteristics necessary to satisfy the requirements. Aside from price, the important factors involved are light output, definition of the image, steadiness of the image, freedom from flicker, durability, wear on film, and simplicity of operation.

The factors that determine the performance of a projector—light output, definition of the image, and random motion of the image—can be measured by means of suitable objective tests. This makes it possible to specify satisfactory performance in terms of values thus obtained. The life of film when projected can also be measured by objective tests that give results suitable for comparison. The durability of a sample projector can be tested in a laboratory and the results certified, thus giving a good indication of the probable life. Other characteristics are of a nature so subjective that their specification is best made in terms of constructional details.

Circular C437, by Robert E. Stephens, which has just been released, discusses in detail the requirements for a satisfactory projector, and describes procedures for making tests of the various characteristics that are involved. Values for these characteristics, representative of the better projectors, are given. This information will assist in the preparation of specifications for projectors and in the selection of ones that will meet the requirements. Copies of C437 are obtainable from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 10 cents each.

A FLOW MANOSTAT FOR VARIOUS PURPOSES

The operation of gas burners at approximately constant rates of heat output, or of gas consumption, the control of various other reactions involving gases, the mixing of gases in different proportions, and many other scientific and technical operations, require the use of gas currents at practically steady differentials above atmospheric pressure. In many instances the pressure of the available supply of gas is much too variable for the purpose in view. This

[1] Published with approval of the Director of the Budget.

is generally the case with ordinary fuel gas or illuminating gas; for example, when gas burners are used in the preparation of certain synthetic compounds, and also when they are used in procedures for analyzing (or for special testing of) certain substances. Various distillations, the estimation of sugars by copper reduction, and the evaluation of the quality of commercial sugars by means of candy tests, are examples of well-known procedures in which constant rates of heating are specified. Pressure variations in the gas service are due, in part, to variations in the demand both within the laboratories and in the surrounding territories.

The simplest means of meeting the situation, in most instances, is to provide locally a pressure regulator for only the gas that is to produce the steady heating. This regulator will be adjusted to serve a particular burner or group of burners which will not be changed in number or capacity during any interval for which the adjustment is to serve. Since the gas going into this service thus will be consumed at a constant rate, a throttling type of regulator should be employed. The devices heretofore used for steadying the pressure differentials between the service gas and the atmosphere in such cases either are not sufficiently effective or else are too elaborate and expensive for general use. The device described by M. J. Proffitt in the Journal of Research for August (RP1492), has proved to be effective and is sufficiently simple for construction in any instrument shop. Indeed, should occasion require, a serviceable unit can be constructed with the hand tools generally available in laboratories and in home workshops.

Since the device is only a flowmanostat, it will not operate "against a dead end." The volumetric rate of flow of the gas from the manostat, at any particular regulated pressure differential, is governed by the back-pressure differential set up by the apparatus served. For example, when the manostat is used to regulate the static pressure differential of the gas served to a burner, the rate of flow is governed by the discharge characteristics of the injector nozzle of the burner. If more than one burner is served simultaneously, the rate of flow from the manostat is governed by the aggregate discharge characteristics of the whole group of burners. Then if the discharge characteristics of any nozzle in the group be changed, the magnitude of the regulated pressure differential will be altered accordingly. This change in the pressure will alter the discharge capacities of all the other burners in the group, until restitution of the original regulated pressure is effected through adjustment of the manostat.

The regulating mechanism of the manostat is a special nonseating needle valve which, in conjunction with the back pressures set up by the apparatus served, operates upon the incoming current of gas to reduce its variable pressure differential to an approximately constant differential of a lesser magnitude which is equivalent to the depression of a hydrostatic column of oil on which the valve floats. Thus the manostat is virtually a sensitive pressure reducer, in which any small change in the reduced pressure differential operates through the hydrostatic column to oppose any further change of the reduced differential in the same direction.

PRECISION OF MOTOR FUEL TESTING

In 1934 the Cooperative Fuel Research Committee decided that sufficient data from cooperative tests were available to warrant an analysis with the object of determining the precision of knock rating and the factors affecting it. The Bureau, in carrying out this assignment, exhaustively analyzed 2,180 tests on 99 fuel samples. A report on this work was published in the SAE Journal for October 1936. By request, a second analysis was made of 6,386 cooperative tests run in 1936, 1937, and 1938, and the report was published in the same journal for October 1939.

In addition to determining the precision of knock rating, these two analyses established rather definitely the factors which influence it. Appropriate steps were taken to eliminate or minimize the adverse effects. The latest analysis, just completed by Donald B. Brooks and R. B. Cleaton, and based on 6,925 cooperative tests, shows the result of these changes.

The three analyses, covering 15,491 knock ratings, show that the precision of rating by both the ASTM Motor and the CFR Research Methods, has steadily improved. At present, about three tests out of four are in error by less than one-half octane unit. Moreover, it appears probable that greater uniformity of technique and more attention to details can reduce the present average error to half its size, as the

tests of some laboratories are now at this level.

Analysis of over 2,000 fuel-inspection tests shows that gravity and vapor-pressure measurements are made with comparable precision by all the laboratories, but the distillation data indicate that some laboratories should conform more closely to the details of the test method if they are to improve the accuracy of their results.

FRACTIONATION OF CELLULOSE ACETATE

It is generally recognized that cellulosic materials are composed of long, unbranched, chainlike molecules of varying lengths. That the length of these molecules exerts an important influence on the physical properties of films and filaments is well known, but the exact nature of the relationship is still not clear. As part of a general program for the investigation of the mechanical properties of textile fibers, research associates for the Textile Foundation at the Bureau are studying the dependence of the physical properties of cellulose acetate on the chain-length of its molecules. A necessary preliminary to this study is the preparation of a large quantity of material carefully fractionated with respect to chain-length.

In the Journal of Research for August (RP1490), Arnold M. Sookne, Henry A. Rutherford, and Milton Harris describe the separation of a sample of commercial cellulose acetate into 15 fractions which vary more than tenfold in chain-length, by a process involving three successive fractionations. The method of separation and some of the characteristics of the fractions are given. It has been shown that a large proportion of the ash and haze-producing materials of the entire starting material is removed in the first fraction, which suggests that an improvement in the clarity of cellulose acetate films might be effected by a rough fractionation to remove a small portion of the starting material.

EQUATION FOR THE CRITICAL ISOTHERMS OF PURE SUBSTANCES

In the Journal of Research for August (RP1493), Cyril H. Meyers presents an empirical equation for data along the critical isotherms of pure substances at densities up to 1.1 times the critical density. The equation has five constants in addition to the universal gas constant. Of these five, one is limited to a single value if a simple solution to the equation is to be obtained, three are determined by the critical conditions, and the remaining constant is determined empirically from data other than those for the critical state. Three of the five constants are independent of the substance, one is an explicit function of RT_c/p_cV_c, while the reciprocal of the fifth is found to be practically a linear function of RT_c/p_cV_c for values of that ratio up to 3.8 or 3.9. Thus, the critical isotherms for various substances are so correlated that data on two well-chosen substances, such as hydrogen and carbon dioxide, suffice to determine the fourth constant and consequently the critical isotherm for other substances, for which RT_c/p_cV_c is not greater than 3.8. For substances such as ammonia (for which RT_c/p_cV_c is 4.08) the fourth constant may not conform to the linear relation.

The equation represents the data for 12 out of 13 substances within the experimental error, the exceptional substance being water (for which RT_c/p_cV_c is 4.34). At low densities the equation reduces to a simpler form which expresses pV/RT as a quadratic function of density.

The fugacity (tendency to flow away) along the critical isotherm can be calculated from the equation. The fugacity at the critical state is approximately two thirds the critical pressure for all substances. The fugacity of CO_2 is calculated at 1 atmosphere and at the critical pressure.

OXIDATION OF CELLULOSE

The potential scarcity of textile materials during the present emergency makes it more important than ever that adequate means be taken to prolong their usefulness. The useful life of a textile material does not begin until the fibers of which it is made have undergone a series of mechanical and chemical treatments, some of which tend to reduce the strength of the material. Obviously, it is desirable to keep this loss at a minimum. For example, the undesirable yellowish color of cotton goods can be removed by treatment with mild oxidizing agents, such as dilute solutions of sodium hypochlorite or hydrogen peroxide, but although care is taken to avoid damage to the goods during this operation, some loss in strength may occur. Adequate control to prevent this type of damage requires a thorough knowledge of the conditions

which produce it. Accordingly, the Textile Foundation's research associates have begun an investigation of the way cellulose is attacked by oxidizing agents.

The first reaction studied was that of cotton cellulose with periodic acid. Periodic acid is not used in bleacheries for processing cotton, but its known selective action made it desirable as a first subject of study in order to form a background for the proper understanding of the action of the common bleaching agents. It was found that in some cases, the action of this oxidizing agent does not result in a direct loss in strength but, rather, in a latent type of damage. Such damage is not indicated by usual strength tests until the bleached product is laundered or otherwise subjected to alkaline solutions. It appears that, in these cases, reduction in the chemical stability of the cellulose molecules of the cotton is insufficient to impair appreciably the original strength of the material. Further treatment of the chemically unstable groups with alkalies results in far-reaching alterations in the molecular structure, thereby producing the loss in strength.

Research Paper RP1491, by Henry A. Rutherford, Francis W. Minor, Albert R. Martin, and Milton Harris, in the August Journal of Research gives the complete report on this reaction.

SUBSTITUTE FOR TINFOIL IN CURING DENTAL RESINS

In cooperation with the Research Commission of the American Dental Association, a substitute for tinfoil has been developed that is quite satisfactory for use in curing dental resins.

A film of a soluble alginate is applied to the plaster. After the film has dried it is rendered insoluble and thus protects the resin during curing or molding.

Two solutions are required. The first is prepared by dissolving 5 or 6 grams of a soluble alginate (Kelco Products Co., San Diego, Calif.), such as potassium, sodium, magnesium, or ammonium alginate, in 80 ml of water. This may require several hours of constant stirring. When solution is complete add 80 ml of glycerine. This first solution can be applied by dipping, spraying, or painting. After the film has dried, a second solution is applied.

The second solution contains metallic ions which will convert the soluble film to an insoluble film. A saturated solution of calcium chloride is satisfactory.

The halves of the flask, after the wax has been boiled out, are dipped in the first solution and allowed to drain and dry for a few minutes. A second dipping may be necessary if the solution is too thin or if the plaster does not retain a sufficient amount of the solution to form a continuous film. The halves are next dipped in the chloride solution for 5 or 10 minutes and then dried. The film can be removed from the teeth with a sharp needle-hook instrument similar to an explorer.

The flask is now ready for trial packing and with a moderate amount of care will retain the film until the cure is completed in boiling water.

The substitute has advantages over the foil in that it is easier to apply, takes less time at the bench, gives a smoother surface, and yields easier separations of the halves of the flask.

A patent application has been filed with proper assignments to the Secretary of Commerce to protect the Government and the dental profession. The invention was perfected by Irl C. Schoonover and George R. Dixon of the dental research staff stationed at the Bureau.

THICKNESS OF THE COLD-WORKED SURFACE LAYERS

Metallographic examination after etching a polished surface, prepared by a series of successively finer abrasive treatments, frequently fails to reveal a structure truly characteristic of the metal, the structure having been modified by the various treatments used. Specific abrasive treatments, employed in metallographic polishing, generally are selected on the basis of the fineness of scratches and pits produced during the abrasion. The presence of a modified structure, however, indicates that in addition to fineness of scratches and pitting, a specific abrasive treatment should be evaluated with respect to the thickness of the altered surface layer that always is produced when a surface is abraded.

The possibility of using X-ray patterns produced by the back-reflection method as a means of estimating the thickness of altered surface layers on annealed metals resulting from metallographic polishing treatments was recently investigated by H. C. Vacher, of the Bureau's Metallurgy Division. The results, which are given in RP1494 in the August Journal of Research, showed that the degree of diffuseness of back-reflection patterns can be used for this purpose when the thicknesses of the altered surface layers are between 2 and 25 microns on steel (0.34 C), 2 and 42 microns on copper and 5 and 95 mi-

crons on aluminum. Additional results indicated that the thickness of the altered surface layer resulting from an abrasive treatment, such as 000 emery polishing paper, was thicker than that resulting from a coarser abrasive treatment, such as 400 grit paper (Aloxite).

FORMATION OF AUSTENITE IN AN IRON-CARBON ALLOY

The ease or difficulty with which a steel may be hardened, that is, its hardenability, is influenced by the size of its grains at the time of quenching. To attain full hardening, coarse-grained steels usually may be cooled at considerably slower rates from the quenching temperature than fine-grained steels of similar composition. It is important, therefore, to understand the mechanism of the formation of these grains and to know the effects of different factors that influence their size at heat-treating temperatures.

A study of the formation of austenite grains (that is, the grains in steels or alloys at relatively high temperatures such as those used in hardening) in a high-purity alloy of iron and carbon (0.50 percent carbon) has recently been completed by Thomas G. Digges and Samuel J. Rosenberg, and is reported in the August Journal of Research (RP1489). These grains are formed by a process of nucleation and growth. It was observed that in the initial stages of their formation these grains were always fine but that they often grew rapidly at temperatures lower than those ordinarily used in hardening. The dominant factor in establishing the grain size of this alloy was, therefore, the rate of growth, not the rate of nucleation.

FREEZING AND THAWING TESTS OF BRICK

In Building Materials and Structures Report BMS60, the results of 50 cycles of freezing and thawing were reported for 3,328 building brick which had been subjected to the current standard method of freezing and thawing of the American Society for Testing Materials. Analyses of these data indicated that relatively few of the soft-mud bricks from the New England district failed in 50 cycles, even though some of these bricks had physical properties indicating low durability, such as high absorptions, high saturation coefficients, and relatively low strengths, and were classified by the manufacturers as either "light hard," "interior," or "soft." The failures that did occur during 50 cycles were, in nearly all instances, on bricks the properties of which were outside of the physical limits prescribed for the SW grade of ASTM Specification C 62–41T. Other samples of these high absorption, soft-mud bricks performed poorly in exposure tests. To study these discrepancies between the results of 50 cycles of freezing and thawing and (a) the manufacturer's classifications, (b) the physical properties usually effective in separating durable from nondurable bricks, and (c) the results of exposure tests, 5 bricks from each of 10 New England brick plants were recently tested by J. W. McBurney of the Bureau's Masonry Construction Section. Each group of 5 bricks represented the extreme vertical range of the kiln. The results of this work were announced at the annual meeting of the ASTM on June 26.

The usual specification tests (absorption, saturation coefficient, and strength determinations) were made on all specimens. In addition, porosity was determined by the gas expansion method, and air permeability was measured using the method described by Stull and Johnson. The half bricks were then subjected to 50 cycles of freezing and thawing by method *B* of the ASTM standard, and the results recorded. An additional 125 cycles by a more severe method were then applied. The following conclusions are based on an analysis of the results of 50 and 175 cycles of freezing and thawing.

(1) Fifty cycles by method *B* caused 15 failures out of 50 bricks, whereas 125 additional cycles caused 23 additional failures.

(2) The following properties are sufficiently well correlated with the results of 175 cycles to permit limits to be established between the range for no failure, random failure, and complete failure: Porosity measured by the gas expansion method; water absorptions by 1-minute cold immersion, by 24-hour cold immersion, and by 5-hour boiling; saturation coefficients measured by porosity (W/V), and by boiling (C/B); and compressive strength.

(3) The following pairs of values for the above listed properties represent the limits for the range of each property within which random failures and passes occur. The figures in parentheses represent the number of specimens within these limits. Porosity (2) 29.8 to 30.9 percent; water absorption by 1-minute cold immersion (9) 1.9 to 4.2 percent; by 24-hour cold immersion (2) 9.7 to 10.9 percent; by 5-hour

boiling (5) 12.2 to 13.8 percent; saturation coefficient by porosity (W/V) (8) 0.61 to 0.65; by 5-hour boiling (C/B) (22) 0.73 to 0.80; and compressive strength (7) 5,500 to 6,400 pounds per square inch.

(4) The following properties of the bricks are so poorly correlated with durability that limits cannot be established: Air permeability, number of capillaries per unit area, average radius of capillaries, and modulus of rupture. It should be emphasized that the above conclusions do not necessarily apply to types of bricks other than those tested.

Insofar as passing a freezing and thawing test is accepted as permitting a waiver of the physical properties required for acceptance in the *SW* grade of the current ASTM specification for building bricks, a more severe test than 50 cycles should be prescribed.

JOHN TUCKER, JR., RECEIVES SANFORD E. THOMPSON AWARD

At the annual meeting of the American Society for Testing Materials in Atlantic City on June 26, the Sanford E. Thompson Award was presented to John Tucker, Jr., chief of the Bureau's Cement and Concreting Materials Section. This award is made each year for the paper of outstanding merit on concrete and concrete aggregates delivered at the previous annual meeting. Mr. Tucker's paper, "Statistical theory of the effect of dimensions and of method of loading upon the modulus of rupture of beams", was read at the 1941 annual meeting ASTM, and was abstracted in Technical News Bulletin 292 (August 1941).

NEW AND REVISED PUBLICATIONS ISSUED DURING JULY 1942

Journal of Research[2]

Journal of Research of the National Bureau of Standards, volume 29, number 1, July 1942 (RP1480 to RP1488, inclusive). Price 30 cents. Annual subscription, 12 issues, $3.50.

Research Papers[2]

[Reprints from the March, April, and May 1942 Journal of Research]

RP1459. Tensile elastic properties of nickel, copper, open-hearth iron, and typical steels. Dunlap J. McAdam, Jr. and Russell W. Mebs. Price 15 cents.

RP1468. Elimination of oxide films on ferrous materials by heating in vacuum. Vernon C. F. Holm. Price 10 cents.

RP1469. Measurements of ultraviolet solar- and sky-radiation intensities in high latitudes. W. W. Coblentz, F. R. Gracely, and R. Stair. Price 10 cents.

RP1470. Rate of oxidation of typical nonferrous metals as determined by interference colors of oxide films. Dunlap, J. McAdam, Jr. and Glenn W. Geil. Price 10 cents.

RP1472. Properties of high-purity iron. Harold E. Cleaves and John M. Hiegel. Price 10 cents.

Circulars[2]

C437. Optical and mechanical characteristics of 16-millimeter motion-picture projectors. Robert E. Stephens. Price 10 cents.

Simplified Practice Recommendations[2]

R97–42. Bell-bottom screw jacks. (Supersedes R97–30.) Price 5 cents.

R186–42. Cotton canton flannels (unbleached) for work gloves. Price 5 cents.

Commercial Standards[2]

CS75–42. Automatic mechanical-draft oil burners designed for domestic installations. (Supersedes CS75–39.) Price 10 cents.

MIMEOGRAPHED MATERIAL

Letter Circulars

[Letter Circulars are prepared to answer specific inquiries addressed to the National Bureau of Standards, and are sent only on request to persons having a definite need for the information. The Bureau cannot undertake to supply lists or complete sets of Letter Circulars or send copies automatically as issued.]

LC694. Thermostat setting and economy in house heating.

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[2] Send orders for publications under this heading only to the Superintendent of Documents, Government Printing Office, Washington, D. C. Subscription to Technical News Bulletin, 50 cents a year; Journal of Research, $3.50 a year (to addresses in the United States and its possessions and to countries extending the franking privilege; other countries, 70 cents and $4.50, respectively).

RECENT ARTICLES BY MEMBERS OF THE BUREAU'S STAFF PUBLISHED IN OUTSIDE JOURNALS [3]

Measurement of the fading rate of paints—Part I. A. J. Eickhoff and R. S. Hunter. Paint, Oil and Chemical Rev. (537 South Dearborn St., Chicago, Ill.) **104**, No. 13, 9 (June 18, 1942).

Measurement of the fading rate of paints—Part II. A. J. Eickhoff and R. S. Hunter, Paint, Oil and Chemical Rev. **104**, No. 14, 6 (July 2, 1942).

Optimum time of delay for parachute opening. W. A. Wildhack. J. Aeronautical Sciences (30 Rockefeller Plaza, New York, N. Y.) **9**, No. 8, 293 (June 1942).

Normal pressure tests of circular plates with clamped edges. Albert E. McPherson, Walter Ramberg, and Samuel Levy. NACA Technical Note 848 (National Advisory Committee for Aeronautics, Washington, D. C.). (June 1942). (Restricted distribution.)

Normal pressure tests of rectangular plates. Walter Ramberg, Albert E. McPherson, and Samuel Levy. NACA Technical Note 849 (June 1942). (Restricted distribution).

It's time to face facts on furniture. Hugh B. Johnson. The Nation's Schools (919 North Michigan Ave., Chicago, Ill.) **30**, No. 1, 26 (July 1942).

The *beta* anomaly of Ruhemann and Simon in rubber. Lawrence A. Wood. J. Chemical Physics. (American Institute of Physics, 175 Fifth Ave., New York, N. Y.) **10**, 403 (June 1942).

Colorimetry of pulp and paper with special reference to "brightness and whiteness". Deane B. Judd. Pulp and Paper Magazine of Canada (National Business Publications, Ltd., Gardenville, P. Q., Canada) **43**, 94 (1942).

Edward C. Groesbeck, an appreciation. H. S. Rawdon. Mining and Metallurgy (29 West 39th St., New York, N. Y.) **23**, No. 427, 409 (July 1942).

Microstructural characteristics of high-purity alloys of iron and carbon. T. G. Digges. Trans. Am. Soc. for Metals (7301 Euclid Ave., Cleveland, Ohio) **30**, 287 (June 1942).

Effect of grain size and heat treatment upon impact toughness at low temperature of medium carbon forging steel. S. J. Rosenberg and D. H. Gagon. Trans. Am. Soc. for Metals, **30**, 361 (June 1942).

Evaluation of fatigue damage of steel by supplementary tension-impact tests. J. A. Kies and W. L. Holshouser. Preprint 31, Am. Soc. for Testing Materials (260 South Broad St., Philadelphia, Pa.) (June 1942).

The National Bureau of Standards in war simplification and standardization work. Lyman J. Briggs. Industrial Standardization and Commercial Standards Mo. (29 West 39th St., New York, N. Y.) **13**, 149 (June 1942).

[3] These publications are not obtainable from the Government. Requests should be sent direct to the publishers.

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